SALMON RECOVERY SCIENCE REVIEW PANEL
Report for the meeting held
January 3-4, 2002
Northwest Fisheries Science Center
National Marine Fisheries Service
Seattle, Washington

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Recovery Science Review Panel

The Recovery Science Review Panel (RSRP) was convened by the National Marine Fisheries Service (NMFS) to help guide the scientific and technical aspects of recovery planning for listed salmon and steelhead species throughout the West Coast. The panel consists of six highly qualified and independent scientists who performs the following functions:

1. Review core principles and elements of the recovery planning process being developed by the NMFS.
2. Ensure that well accepted and consistent ecological and evolutionary principles form the basis for all recovery efforts.
3. Review processes and products of all Technical Recovery Teams for scientific credibility and to ensure consistent application of core principles across ESUs and recovery domains.
4. Oversee peer review for all recovery plans and appropriate substantial intermediate products.

The panel meets 3-4 times annually, submitting a written review of issues and documents discussed following each meeting.

Expertise of Panel Members

Common to many/all panel members:

- Involvement in local, national and international activities
- Participation in National Research Council activities
- Service on multiple editorial boards
- Numerous publications in prestigious scientific journals

Dr. Ted Case

- University of California- San Diego
- *Field of expertise*: evolutionary ecology, biogeography and conservation biology
- *Awards*: Board member for National Center for Ecological Analysis and Synthesis; Research featured in prominent scientific journals (Science, Nature) popular science journals (American Scientist, Discover), on public television and public radio
- *Scientific leadership*: Chair of department of Biology at UCSD and author of leading textbook on theoretical ecology;
- *Research*: More than 116 scientific articles published

Dr. Frances C. James

- Florida State University
- *Field of expertise*: conservation biology, population ecology, systematics, ornithology
- *Awards*: Eminent Ecologist Award (Ecological Society of America); Leadership and dedicated service awards from the American Institute of Biological Sciences
- *Scientific leadership*: Participant on National Research Council Panels; service on many editorial boards; Board of Governors for The Nature Conservancy; scientific advisor for national, state and local activities;
- *Research*: More than 105 scientific articles published

Dr. Russell Lande

- University of California-San Diego
- *Field of expertise*: evolution and population genetics, management and preservation of endangered species, conservation and theoretical ecology

- *Awards*: Sewell Wright Award (American Society of Naturalists); Fellow - John Simon Guggenheim Memorial Foundation, MacArthur Foundation, American Academy of Arts and Sciences
- *Scientific Leadership*: President of the Society for the study of Evolution; International Recognition; developed scientific criteria for classifying endangered species adopted by the International Union for Conservation of Nature and Natural Resources (IUCN)
- *Research*: More than 116 scientific publications

Dr. Simon Levin

- Princeton University
- *Field of expertise*: theoretical/mathematical ecologist
- *Awards*: National Academy of Sciences member; Robert H. MacArthur award recipient from the Ecological Society of America; Statistical Ecologist Award from the International Association for Ecology; Distinguished Service Award from the Ecological Society of America
- *Scientific leadership*: Member of many National Research Council panels; Board of Director member for Santa Fe Institute, Beijer International Institute of Ecological Economics, The Committee of Concerned Scientists
- *Research*: More than 275 technical publications

Dr. William Murdoch

- University of California Santa Barbara
- *Field of expertise*: theoretical and experimental ecologist, population ecology
- *Awards*: Robert H. MacArthur award recipient from the Ecological Society of America; President's Award from the American Society of Naturalists; Guggenheim Fellowship
- *Scientific leadership*: Founder of National Center for Ecological Analysis and Synthesis; Director of Coastal California Commission 10-year study; scientific advisory panel member for the Habitat Conservation Plan for the California marbeled murrelet
- *Research*: More than 118 scientific publications

Dr. Robert Paine (chair)

- University of Washington
- *Field of expertise*: marine community ecology, complex ecological interactions, natural historian,
- *Awards*: National Academy Sciences member; Robert H. MacArthur award recipient from the Ecological Society of America; Tansley Award (British Ecological Society); Sewell Wright Award from the American Society of Naturalists; Eminent Ecologist (Ecological Society of America)
- *Scientific leadership*: Member of multiple National Research Council panels, editorial boards, past president of Ecological Society of America
- *Research*: About 100 scientific publications

Dr. Beth Sanderson

- National Marine Fisheries Service liaison to the Recovery Science Review Panel
- Recovery Science Review Panel report coordinator

Richard Farr

- Science Writer, Northwest Fisheries Science Center

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II. HABITAT IMPROVEMENT

III. MODELING THE NUMBER OF POPULATIONS NECESSARY TO MINIMIZE THE EXTINCTION RISK FOR ENTIRE ESUS

IV. REGIONAL ANALYSIS OF THE '4H' FACTORS

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1. The Cumulative Risk Initiative

The CRI group has been enormously productive and constructive despite its apparent divergence from some aspects of NMFS culture. Its work is characterized by crisp analysis and by a readiness to re-evaluate archival data and question cherished approaches; it has already identified some weaknesses in current quantitative tools. Despite being diffused throughout the Center, it has promoted creativity at the NWFSC, and it also has an outstanding record of publication in first rate, non-fishery peer-reviewed journals—a fact that advertises the quality of NMFS science well beyond the usual audience.[1] We look forward to excellent future work from the CRI in such areas as bioeconomics, scenario planning and spatial modeling.

2. Habitat improvement

The application of GIS and remote-sensing technologies has promise for identifying and prioritizing specific habitat improvement actions within ESUs and watersheds. However, we are still unsure how actions will be prioritized and implemented on the ground in such a way that we can learn in the process by adaptive management experiments.

The GIS approach could be used to identify groups of matched sites, and these could be treated differently in large-scale experiments that alter habitat in different ways. As yet, however, and despite several pleas in our previous reports, we do not see a coordinated action plan to organize and implement habitat improvements in an adaptive manner. There is an opportunity here, and the Center should not lose it: plan habitat improvement in a way that will make future comparisons relatively easy.

[1] For example: Kareiva et al. (*Science* 2000); Holmes (PNAS 2001, *Ecological Applications* 2002); Levin et al. (*Conservation Biology* 2002); McClure et al. (*Ecological Applications*, in review); Zabel and Williams (*Ecological Applications* 2002).

Both siltation and water diversion—two problems identified in the SHRP document—seem amenable to small-scale restoration efforts and experimental manipulation—but how will these efforts be assessed? For instance, the preliminary results on blockages, presented by T. Beechie and P. Roni, suggest that reducing blockages to potential breeding grounds in some regions may be one effective way to enhance habitat for salmon. This raises several issues, some of which may benefit from further research:

- Given the strong homing response of adult salmon to return to their natal spawning grounds, how quickly would a newly accessible stream be colonized and how do these colonization rates differ from natural stray rates?
- Would hatchery fish or wild fish be more likely to colonize new areas?
- Would fish have the behavioral flexibility to assess the suitability of new areas for breeding and spawning compared to their natal areas?

If, in addition, the culvert replacement program currently under way could be cast as an experimental manipulation across paired, compatible watersheds, a lot could be learned quickly about the efficacy of this restoration technique.

Michelle McClure's important study showed how the uniform application of irrigation screens could increase lambda; coupling results like this to economic models ("biggest bang for the buck" approach) seems essential.

3. Modeling the number of populations necessary to minimize the extinction risk for entire ESUs

As a heuristic guide, the model presented by Paul McElhany illustrates how quickly extinction probabilities for an entire ESU might decline when the number of independent populations within it increases. In the model, extinction risk is independent of population size, as might be the case for catastrophic extinction. However, there may be a problem with the assumption that there is no spatial correlation for catastrophic risk factors leading to extinction; and, if such correlations exist, then the model will under-estimate the probability of extinction.[2] In the case of salmon ESUs, populations share a more-or-less common marine environment, as well as migration routes over parts of the watershed—enforcing some degree of environment sharing at some stages of the life history. Hence there may be spatial correlation in extinction risk across populations. By ignoring this, the model underestimates the ESU extinction risk for any number of populations within it.

We suggest a more mechanistic exploration of the problem that begins with identifying several likely scenarios that might lead to population extinctions. For example, one historical cause of local extinction has been landslides blocking streams. The pattern of spatial correlation could be deduced by following fault lines or by using historical records of seismic activity over space. Another possible scenario is a large oil spill in near-shore habitats, which might simultaneously affect several populations at once. It might be possible, by beginning with specific scenarios, to get a better quantitative handle on the spatial correlation of such disasters and then feed that back into the model to better predict ESU extinction risk from catastrophes.

[2] This has been noted before; see for example J.F. Quinn and A. Hastings, 'Extinction is subdivided habitats,' *Conservation Biology* 1:198-208, 1987, and compare M.E. Gilpin, 'A comment on Quinn and Hastings: Extinction in subdivided habitats,' *Conservation Biology* 2:290-292, 1988.

4. Regional Analysis of the "4H" factors

Jon Hoekstra, Mary Ruckelshaus and their collaborators reported their progress on constructing a dataset on the 4H factors (habitat, hydropower, harvest, and hatcheries) thought to be important in historical declines of Pacific salmonids, and on estimates of response variables. The database now includes substantial information on most or all of these factors for numerous runs in the entire Pacific Northwest. The group reported that data are available on population change between 1980 and 2000 and current population size.[3]

Independent variables for habitat will include the percentage of land cover and water temperature; hydro / dam information will have separate variables for upstream and downstream dams; harvest data will be from harvest in indicator stocks; and the hatcheries data will include the number of hatchery-reared fish released. Information on how long the changes have been in effect should be included.

The plan now is to explore factor and path analytic approaches to the data. The main objective is to formulate a model in which the status of a focal species is the response variable and the dependent variables are important processes that affect that status.[4] One goal is to derive standardized coefficients and do significance tests on them, accounting for spatial correlation in the response variable, and allowing a fairly general but unanalyzed spatial correlation structure in the 4Hs. The results could be of central importance to prioritizing regional recovery efforts. The usual method of doing regression analysis of spatially distributed data, as described by Cressie, may not be adequate given the particular complexities of this problem.[5]

The RSRP Committee was asked for advice on the most appropriate response variables, and suggestions on how to deal with the correlation structure of the 4 H factors imposed by the geographic structure of river systems. We suggest that current population size is not an appropriate response variable, since differences in habitat size that are 4H-independent (e.g. basin size) would make large variations in run size only natural. We also note that using any measure of habitat alteration to reconstruct historical run sizes would be partly circular, since it would confound the response variable with one of the 4 Hs. It therefore appears impossible to perform a quantitative retrospective assessment of the relative importance of the 4 Hs in causing historical run declines. Nevertheless, it is of great interest and practical importance to carry out the analyses using lambda (the finite rate of population increase) as the response variable.

The committee senses that these issues require further discussion, and may require some statistical consultation as they develop. In the meantime, we are reluctant to make strong recommendations regarding the 4H analysis.

5. The Salmon Habitat and Recovery Planning (SHRP) document

The ecosystem restoration approach that SHRP takes is good, as is the approach of looking at the processes that are driving habitat change and emphasizing their modification. SHRP should not

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[3] In most cases it is not possible to reconstruct historical run sizes, except with difficulty and by indirect methods such as using geological information to estimate river miles of suitable spawning beds.

[4] In that sense the project is extending the approach of Andrewartha and Birch in their construction of envirograms. H.G. Andrewartha and L.C. Birch, *The ecological web: more on the distribution and abundance of animals*. University of Chicago Press, Chicago, 1984.

[5] N. Cressie, Statistics for spatial data (revised edition). John Wiley and Sons, New York, 1993.

shy away from making specific approaches—the reader certainly expects to see them in a technical memorandum. A good example is Appendix A, on the activities of the Skagit Watershed Council, which does get specific about fencing and planting within 40 meters of a stream. (Note: is it 40 meters on each side?) Some things are less clear:

- Of the 400 identified projects, how many have been implemented?
- Do we have "before" and "after" measurements at the same time of year?
- What is covered by the vague term "man-made disturbances"?

6. The future

Perhaps the most important observation we can offer is that there is obviously more to ESA-listed salmonid restoration than the 4Hs—a catchy tag that tends to obscure or diminish the importance of an array of other factors. A partial list of topics that don't comfortably fit in the 4H pigeonholes might include:

- Pacific decadal oscillations, climate shifts generally, and at-sea conditions;
- Estuaries: in one sense they are part of habitat, but another sense restricts habitat to areas in which salmon spawn;
- The role of exotic species, e.g., cord grass in the estuaries, Atlantic salmon, shad, walleye, sundry bass, etc.;
- Interspecific interactions e.g., predation by Caspian terns, marine mammals;
- The frequency with which the promise suggested by large spawning runs is compromised by subsequent low rainfall/runoff or hydro demands;

Several issues worth mentioning arose from our January 2002 meeting as "surprises"—they appeared spontaneously, often in informal contexts:

- One of our earlier meetings focused on hatcheries, but the intriguing concept of a temporary *recovery hatchery* wasn't mentioned then, and came up at this meeting only as an after-thought;
- Life history variation, especially characteristic of chinook, needs to be restored. Hatchery biologists have successfully diminished the age at first reproduction for salmon; have there been targeted attempts to restore the long-lived life history types of fish within a specific run or stock that, say, spend 5-6 years at sea?
- If wild salmon are ten times as likely to strike a lure during their spawning runs as their hatchery counterparts, this represents an impressive and selective bias in sources of mortality—what are the genetic and conservation consequences?

The RSRP would like to know more about just what the situation is on state lands and private timberlands, as well as federal lands, for instance, what the USDA, Forest Service and forestry industry are doing about roads that erode into salmon streams, and whether there is any chance for coordinated programs in the future to reduce siltation. It would also be useful to hear from state governments about whether they could use financial inducements to get diversions modified and farm animals fenced off from important stream areas. Scientifically, this would be extremely useful if there were planned comparisons and difference measurements. Here the response variables can be more flow and less siltation. We don't have to measure the results in redds, at least not in the beginning.

It is time for NMFS to start integrating projected costs with the likely benefits of specific recovery actions. According to current assumptions, the NWFSC should stick to doing science while others do everything else. Neither the RSRP nor the NWFSC should be making policy decisions; on the other hand, we should be reevaluating the relationship between science and policy, and we should be including economic considerations as part of our scientific evaluations.

The RSRP's upcoming meetings are likely to focus on two things: habitat, and the needs of both the developing and the more established TRTs. However, the bulleted items above should not be ignored, and new data relevant to salmon ESU recovery will only expand the list.

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